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PROCESSING OF CZECHOSLOVAK NICKEL ORES

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[Comment: This report presents information on proposed Czechoslovak nickel smelting operations, as discussed in an article by M. Pedlik of the Nonferrous Metals Research Institute in Panenske Brezany. The article, first published in a 1954 issue of Za Socialistickou Vedu a Techniku (For Socialist Science and Technology), was translated into German by A. Tiefenbach.]

The rising demand for alloying elements forces Czechoslovakia to utilize domestic sources of raw materials. This is particularly true of metals which need to be imported from capitalist countries.

One such metal is nickel, which is used in great quantities for the manufacture of structural steel, as well as stainless and heat-resisting alloys. Heat-resisting alloy steels contain up to 20 percent nickel.

Other important alloying operations involve nickel and copper, nickel and molybdenum, and other metals. Nickel is also used extensively in electroplating. The demand for nickel is increasing not only in Czechoslovakia, but also in the rest of the world.

During recent years, world production of nickel has been about three times as great as pre-World War II production, with the USSR assuming an ever rising role as a nickel producer.

Several People's Democracies are attempting to meet the demand for nickel from domestic raw materials as far as possible. Poland is building a new nickel smelter, and similar installations are being planned in the GDR and in Czechoslovakia.

Deposits of nickel-bearing ores with a nickel content of more than 5 percent are becoming more scarce, so that the transition must be made to smelting nickel silicates with a nickel content of one percent. Nickel deposits in Czechoslovakia are concentrated mainly in southern Bohemia. The so-called laterite ore [found there] contains between 0.2 and 1.5 percent nickel, along with 10-20 percent iron. The actual nickel ores are colloidal hydrous silicates.

Because of the high silica content, these ores cannot be economically smelted by the normal method, where the nickel in the ore is collected in nickel matte. Consequently, a new method of smelting must be found which will be economical despite the low nickel content of the ore.

The following methods can be considered:
1. Production of ferronickel in a rotary kiln (Krupp-Renn process).
2. The ammonia leaching process.

## Production of Ferronickel in a Rotary Kiln

This process can be considered for the laterite ore and consists of a reduction of the ore, not unsimilar to the Krupp-Renn process.

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By this method, an alloy of iron and nickel is obtained. The nickel ore is placed in a rotary kiln, together with 20-30 percent lime and coke or blast furnace slag, and is heated to between 1,200 and 1,300 degrees centigrade. The dough-like product is ground and sifted, and large chunks are removed. The sifted product is then subjected to treatment by magnetic separators and again magnetic chunks are formed. The ferronickel thus obtained in chunks can contain the following percentages of the elements indicated, depending on the iron content at the beginning of the process: nickel, 6-10; sulfur, 0.4-1.5; phosphorus, 0.1-0.6; and the rest iron.

This relatively simple process permits the extraction of 80-85 percent of the nickel contained in the ore. The high sulfur and phosphorus content can be further reduced to acceptable limits through refining. However, the experimental refining process has proved to be very expensive and lengthy. Another shortcoming of this method is that the end product consists of iron with a relatively low nickel content, which is not suitable for use in the production of high-alloy nickel steels.

Ammonia Leaching Process

Finely ground ore is reduced at a temperature of 700-800 degrees centigrade, with the aid of producer gas in a shaft furnace. After cooling, without access of air, the resulting product is leached in ammonium carbonate lye. During the leaching the nickel goes into solution, whereas the iron, which was only reduced to a low oxidation point, remains insoluble.

The ammonia solution contains 2-10 grams per liter of nickel in the form of complex salt. The ammonia and carbon dioxide are driven out of the solution by steam and leave a very pure nickel carbonate, with a nickel content of approximately 50 percent. The ammonia and carbon dioxide are absorbed and reused.

The resulting nickel carbonate is either processed electrolitically into very pure cathode nickel, or heated to nickel oxide. Nickel oxide is briquetted and can be introduced directly into open hearth-type furnaces. The nickel in the nickel oxide is suitable only for use in a steel mill and is not suitable for the manufacture of nonferrous metal alloys and for nickel plating.

The ammonia leaching process can yield up to 65-75 percent of the nickel contained in the ores, depending on the nickel content of the ore and on the bonding characteristics within the ore. The metal produced by this process appears to be more productive than the Krupp-Renn process for alloying.

Steam and producer gases, as well as ammonia (which is available in large quantities and at little cost in Czechoslovakia), are needed for the ammonia leaching process. The one disadvantage of this process is that it requires the creation of production facilities in whose design Czechoslovakia has had no experience. The chemical industry, however, does have some facilities which could be adapted for use in the smelting of nickel.

The electrolysis requires about 3 kilowatts of electric power per kilogram of nickel obtained. Power is also required to drive the various grinding and mixing machines, conveyer belts, and miscellaneous auxiliary equipment. Large quantities of low-pressure steam (about 6 kilograms per kilogram of nickel) are required for processing the leaching solution and the leaching sediment. Consequently, it is advisable to build a bleeder-type turbine in the nickel smelter, so that the surplus steam from the turbines can be suitably utilized. In this manner, it is possible for the nickel smelter to provide its own power.

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As far as the cost picture of ammonia-leached nickel is concerned, the amortization of the production facilities forms the bulk of the expenditure, since the existence of a nickel smelter is considered suitable only as long as supplies of ore are available. The amortization costs and the general production costs would be cut considerably if Czechoslovak geologists were to find additional nickel deposits in Czechoslovakia, or if existing ore deposits prove to be more productive than originally estimated. Also, costs could be reduced if it became feasible to concentrate ores with a nickel content of less than 0.4 percent. Low nickel content ores are available in much larger quantities in Czechoslovakia than ores with a high nickel content.

The smelting of low nickel content ores is very expensive. The enriching of poor ores through various dressing processes is a difficult problem, because of the colloidal character of the ore. However, enriching ores up to 0.7-0.8 percent nickel would already be an advantage. This could be achieved, for example, by removing part of the silicous gangue which now comprises about 60 percent of the ore.

The smelting of south Bohemian nickel-bearing ores has been solved from the research and development standpoint; all that remains to be decided is the design and construction of a suitable smelter and its capacity. The mining of nickel ore presents no problem, since the ore could be strip-mined and would thus not require the use of any complicated installations or equipment.

The utilization of the available nickel-bearing ores is of great economic significance. The smelting of the south Bohemian nickel-bearing ores will render the importation of raw materials for the production of nickel unnecessary.

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